Effects of Ensiling and Pelleting on Nutrient Utilization of Oil Palm (Elaeis guineensis) Frond by Goats

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ABSTRACT: Effects of ensiling and pelleting of oil palm frond (OPF) on nutrient utilization was examined. Fresh-chopped OPF were ensiled and pelleted. Determination of proximate, cell wall and cell components of fresh-chopped, ensiled and pelleted OPF, their digestibilities and nutrient intakes were determined. Ensiling and pelleting altered DM, OM, CP and CF contents of OPF significantly, but no significant change was found on cell and cell wall components except total carbohydrate (TC). Both the treatments increased potential degradability and the rate of degradation of OPF. Potential degradability (B) of the ensiled and pelleted OPF were higher (P<0.01) than that of fresh-chopped OPF. The highest rate of DM disappearance (c; 0.0344 h⁻¹) obtained in ensiled OPF followed by pelleted OPF and fresh-chopped OPF. Fresh-chopped and ensiled OPF produced significant amounts of OPF refusals, but pelleted OPF produced almost no refusals. Nutrient intake and digestible nutrient intakes were higher (P<0.001) on pelleted OPF based diet. The result suggested that pelleting could be a way to preserve the harvested OPF.

Key words: Oil palm frond, Ensiling, Pelleting and Nutrient Utilization

INTRODUCTION

Oil palm frond is produced a large amount throughout the year, but it is less convenient to collect and store. In order to preserve the OPF, development of preservation techniques are needed. Ensiling and pelleting are the commonly used methods for forage conservation. Ensiling of OPF increased the nutrients and DM degradability, but decreased the voluntary intake (Nasir Hassan et al., 1997). Nutrient content of ensiled OPF was higher when OPF treated with urea and/or molasses prior ensiling, but the DM intake of the OPF was low, which could not support the required OM for maintenance of the goats (Islam, 1999). It was also found that, the goats selected only leaflets and refused petioles when the fresh-chopped and ensiled OPF were offered (Dahlan, 1992; Islam, 1999) that resulted in low nutrient intake. Furthermore, ensiling requires drums or silos and a large place to store.

Oil palm frond is a lignocellulosic fibrous material (Islam, 1999). Processing methods involving physical, chemical and microbial treatments could improve the nutritive value and intakes of lignocellulosic fibrous materials (Kiflewahid, 1982). Particle size of forages has a significant role in rumen digestion. Pelleting alters the physical form or particle size, to preserve and to isolate specific parts, to improve palatability or digestibility or to alter nutrient composition or to detoxify. Pelleting increased the coarse fiber intake and nutritive value, and help in preservation (Sundstol and Owen, 1984). Feed processing and conservation are desired to increase the level of feeding for maximum production. Thus, feed processing with a greater mechanization becomes more important for large animal production. This applies particularly to the less convenient fibrous feed. Owing to this, it is anticipated that pelleting could be a way to conserve OPF. Therefore, the effects of ensiling and pelleting of OPF on nutrient content, nutritive values and the effectiveness of them in OPF utilization were studied.

Materials and Methods

Preparation of feeds

The senescence and harvested fronds were collected from Universiti Putra Malaysia plantation. They were chopped using a simple electric chopper (Star Farm, Model SFC 1400, Japan) into 2.0 to 3.0cm pieces. Ensiled OPF was prepared using the fresh and chopped OPF. The fresh-chopped OPF were packed in 200L drums and tightly sealed manually, to provide anaerobic conditions. The drums were kept at room temperature for 60 days. The fresh-chopped OPF were sun-dried for a day followed by mechanical drying for an hour to raise the DM content of chopped OPF is >850g.kg⁻¹. The dried and chopped OPF were then ground by Delta Frond Grinder (FG 5000) to pass 4.0 to 5.0 mm sieve size. The ground OPF were then mixed, steamed, molded and pelleted (1 to 2 cm size) by KAHL pelleting machine (HTR 150, Germany).

GOATS AND THEIR MANAGEMENT

A feeding and digestibility trial of 56 days was conducted with a 10-day adjustment period prior to the feeding trial. Twelve Malaysian local crossbred goats of 10 to 12 months of age with an average body weight of 20.5±0.5 kg were used. Goats were divided into 3 groups of 4 goats in each group, homogenous for age and weight. The goats were kept in individual pens on a raised wooden slatted floor.

DIET COMPOSITION

Three experimental diets based on OPF were formulated and offered to the goats. The different types of OPF were; freshly harvested and chopped OPF, chopped OPF ensiled without any preservative and pelleted OPF. The compositions of diets are shown in Table 1.

Commercially available concentrate pellet (goat-pellet) were used as supplement feed. The goat pellet was used @ 1% (as fed) of live body weight of the goats.
Intake and digestibility measurement

Fresh-chopped and ensiled OPF were offered ad libitum (based on 140% of the previous day intake) twice daily at 08:00 h and 16:00 h and the concentrate was offered in the morning prior to OPF. The OP pellet was offered as per 115% of the total dry matter intake of the previous day. Daily feed intake was measured by recording the weight of fresh feed offered and feed refusals. Digestion trials of the diets were conducted during the 3rd and 6th week of the feeding trial using total feces collection method. Goats were kept in individual metabolic crates. About 10% of total well-mixed feces of were collected. Feed, refusals and fecal samples were further sub-sampled, dried, ground and stored. Apparent digestibility of DM, OM, CP and ADF were determined by subtracting the nutrient voided through feces from the nutrient intake and divided by the nutrient intake.

Analyses

Samples were analyzed for DM, OM, CP, EE, CF using the method of AOAC (1984), and NDF, ADF, cellulose, hemicellulose, lignin and silica were determined using the method of Goering and van Soest (1970). Total carbohydrates and non-fibrous carbohydrates (NFC) were also calculated. Three Kedah-Kelantan bulls, each fitted with a permanent rumen fistula were used to carry out the nylon bag technique determining the in sacco rumen degradation values (Bhargava and Orskov, 1987). The digestion characteristics were calculated using the NAWAY-NEW program. Data of nutrient contents were analyzed for analysis of variance in a completely randomized design. The mean values were tested for differences with Duncan’s new multiple range test. All the analyses were carried out using SAS (1997).

RESULTS

Nutrient contents

Pelleting and ensiling altered the nutrient contents of the OPF. Pelleting increased (P<0.01) DM and CP contents, and reduced OM and CF content of the OPF (Table 2). Ensiling increased cell content of OPF. Ensiling and pelleting both slightly reduced (P>0.05) fibrous components like cellulose, hemicellulose, lignin and silica contents of the OPF (Table 3).

In sacco degradability

The digestion characteristics measured from the degradation values of three types of OPF are shown in Table 4. Pelleting and ensiling both increased (P<0.05) the rapidly degradable fraction (A) and potentially degradable fraction (B) of the OPF which reflected in the total degradability. Moreover, ensiling and pelleting both increased (P<0.05) the rate of degradation (c) of OPF by 82% and 72% respectively.

Refusals

Goats refused almost 50% of the offered OPF when either fresh or ensiled OPF was given (Table 5). However, goats fed on OPF pellet refused only 10% of the OPF, which evidenced that the use of pelleted OPF could reduce the feed wastes. The OPF intake by the goats fed on fresh-chopped, ensiled and pelleted OPF were 29.69, 33.62 and 49.62 g.kg⁻¹ W0.75. day⁻¹, respectively. The pelleting of OPF increased the OPF intake by 67% while ensiling increased the OPF intake by 13%.

Nutrient intake

Higher (P<0.01) DMI of OPF resulted in higher OM, CP and ADF intakes (Table 5). The OM intake by goats fed the diets of fresh-chopped OPF, ensiled and pelleted OPF were 50.5, 53.8, and 67.3 g.kg⁻¹ W0.75. day⁻¹, respectively. It could be due to that the pelleted OPF was easier to consume and therefore increased the DMI.

Digestibility of nutrient

Apparent digestibility values of the nutrient of the diets are presented in Table 5. Goats fed on pelleted OPF showed significantly highest DM, CP and ADF digestibilities compared to that of the other groups. The OM digestibility was almost similar among the diets. However, no difference (P>0.05) was found on DM digestibility between ensiled and pelleted OPF. followed by ensiled and fresh-chopped OPF.

DISCUSSION

Fresh OPF contained a high moisture which accelerate OPF deterioration (Islam, 1999), pelleting increased the DM of OPF that support easy and long durable storage. Moreover, high DM and desired size of pelleted OPF (1-2cm) might influence the high intake. The OPF consisted of high lignin, silica and other fibers that resulted in the low digestibility of fresh-chopped OPF. Ensiling and pelleting both reduced (P<0.05) the lignin and silica content. Pelleting reduced particle size, open a large space and offering a wider area for microbial attack and subsequently increased DM digestibility. The effect of steaming on OPF during pelleting might have a positive effect on DM digestibility. The increased digestion characteristics (A, B and c) measured by in sacco studies of ensiled and pelleted OPF could be due to the combined effects of pre-treatments (grinding, steaming and molding) occurred during the pelleting. Basile and Machado (1990) found a positive effect of steaming on increased digestibility of sugar cane bagasse. Pelleting showed a higher rate of degradation that might influence and produced an increased intake of the feed. The nutrient content, the in sacco degradation characteristics and the in vivo digestibilities of three types of OPF were comparable to that values of the conventional roughages like rice straw, wheat straw and bagasse (Sundstol and Owen 1984, Navatne and Ibrahim, 1988).

A slight higher intake of ensiled OPF could be due to the OPF become soft during ensiling, and the sweetish smell of the silage. The digestibility values of fresh-chopped OPF were higher than the reported value of Nasir Hassan et al. (1997) but lower than the values of ensiled or pelleted OPF observed in this study. However, the digestibilities is comparable to that of
conventional tropical fibrous feeds (Kiflewahid, 1982). The OM intake from different OPF based diets were higher than the reported value of OM intake of Bangladeshi local goats fed grass and concentrate supplement (Islam et al., 1997) and almost similar to the OM of Japanese goats fed on Italian rye grass and concentrate supplement (Islam et al., 2000).

The major disadvantage of a fibrous feed is low voluntary intake (Minson, 1990) that encountered in earlier studies (Islam, 1999) and also found for fresh-chopped and ensiled OPF in this study. Like other low quality fibrous feed, one of the options to maximize the utilization of OPF is to increase the voluntary intake of OPF. Present study showed that pelleting of OPF could enhance the nutrient intake and subsequently increase in digestible nutrients to goats. Although grinding and pelleting sometimes depress the digestibility of fibrous feed, one of the options to improve the quality fibrous feed, one of the options to maximize the voluntary intake (Minson, 1990) that encountered in previous report showed increased (P<0.01) digestibility quality as well as nutrients intake in pelleted OPF. Similarly, pelleting increased the DMI of cassava chips and roots, straw and bagasses (Kiflewaid, 1982, Minson, 1990; Islam 1999). Our result also supported Sommer et al. (1978) who prepared pellet from straw and Lucerne meal with urea (2%) and stated that when straw was decomposed during pelleting its proportion was increased up to 70 to 80%.

Moreover, during pelleting pre-treatments of OPF with urea and/or molasses, supplementation of additives for correcting the nutrient in lacking and steaming could be incorporated which generally increase in digestibility of diet. Although the ADF digestibility in the OPF pellet was low (42%) but it was much higher than the fresh-chopped OPF. Although ensiling of OPF increased the DMI and digestible DMI, but increased the refusal amounts. The refusal obtained from the ensiled OPF was almost similar to fresh-chopped OPF (209.5 vs. 262.8 g.day⁻¹.goat⁻¹). The higher amounts of refusals tend to increase in biomass losses and eventually increase in cost of feed.

Pelleting has many advantages (Kiflewahid, 1982; Sundstol and Owen, 1984). This includes: grading that increases the surface area of the fiber, steaming alter the fibrous constituents increases density of the fiber, easy handling, reduction of waste, more uniform feed, reduction of dust and it is ready to be incorporated into complete feed. They also reported that pelleting increased the digestible energy of the feed. Although, pelleting costs high inputs, but for a large-scale production system and for lengthy storage pelleting is the best (Sundstol and Owen, 1984). Pellets do not require a large space to store like silage. Based on the study, it can be concluded that pelleting could be a better way to conserve and improve the nutritive value OPF and thus the huge amounts of OPF can easily be stored and maximize utilization.

CONCLUSION

This study shows that nutritive quality of OPF is similar to that of tropical roughages. Pelleting of oil palm frond could increase nutrient intake besides decreasing the refusals. More digestible nutrient intake could be obtained using pelleted OPF compared to fresh-chopped and ensiled OPF. Oil palm frond is a waste and almost no value except the cost of collection and transportation. Thus, in the oil palm growing countries OPF pellet could be used as a fibrous feed, which may reduce the pressure of conventional feeds. However, future work should investigate on effects of additives/ or supplements with OPF pellet.

ACKNOWLEDGEMENTS

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Somer, A., L Celkova and J. Vancisin. 1978. Vyskun novych zdrogov synthetickyh elvsikatyh latock pre hovadzi dobytok (zaverecna sprava) (Study of new sources of synthetic substances for cattle feeding) Nitra VUVZ.
Email: salimmi@niai.affrc.go.jp
Table 1. Different types of experimental diets for feeding trial

<table>
<thead>
<tr>
<th>diets</th>
<th>concentrate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ch-sh. OPF</td>
<td>Chopped OPF were collected and chopped + Goat pellet @ 1% of the LW</td>
</tr>
<tr>
<td>ensiled OPF</td>
<td>Fresh and chopped OPF were ensiled in metal drum + Goat pellet @ 1% of the LW</td>
</tr>
<tr>
<td>PF pellet</td>
<td>PF was chopped, ground and mechanically pelleted Goat pellet @ 1% of the LW</td>
</tr>
</tbody>
</table>

Table 2. Nutrient contents (g.kg⁻¹ DM) of fresh, ensiled and pelleted oil palm frond

<table>
<thead>
<tr>
<th>samples</th>
<th>C</th>
<th>EL</th>
<th>lignin</th>
<th>lica</th>
<th>zll</th>
<th>CE</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>fresh OPF</td>
<td>0.6a</td>
<td>8.5a</td>
<td>49.8b</td>
<td>1.0a</td>
<td>9.9a</td>
<td>78.4a</td>
<td>8.8a</td>
</tr>
<tr>
<td>ensiled OPF</td>
<td>14.6a</td>
<td>6.8a</td>
<td>31.0b</td>
<td>1.1a</td>
<td>40.2a</td>
<td>77.8b</td>
<td>8.0a</td>
</tr>
<tr>
<td>pelleted OPF</td>
<td>18.4a</td>
<td>19.7a</td>
<td>75.7a</td>
<td>1.4a</td>
<td>17.2a</td>
<td>77.2a</td>
<td>1.3a</td>
</tr>
</tbody>
</table>

*Representative samples; a, b and c Means with different superscripts within a column are different (P<0.01).

Table 3. Cell-wall and cell constituents (g.kg⁻¹ DM) of fresh, ensiled and pelleted oil palm frond

<table>
<thead>
<tr>
<th>samples</th>
<th>C</th>
<th>EL</th>
<th>lignin</th>
<th>lica</th>
<th>zll</th>
<th>CE</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>fresh OPF</td>
<td>.77a</td>
<td>.96a</td>
<td></td>
<td>.65b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ensiled OPF</td>
<td>.70</td>
<td>1.10</td>
<td></td>
<td>1.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pelleted OPF</td>
<td>.92c</td>
<td>.99b</td>
<td></td>
<td>.39a</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a, b and c Means with different superscripts in the same row differs significantly.

Table 5. Nutrient intake of goats and digestibility of nutrient of fresh-chopped, ensiled and pelleted oil palm frond

<table>
<thead>
<tr>
<th>samples</th>
<th>int fresh OPF</th>
<th>Diet ensiled OPF</th>
<th>Diet pelleted OPF</th>
<th>g. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>PF DM offered</td>
<td>14.1</td>
<td>6.4</td>
<td>17.7</td>
<td></td>
</tr>
<tr>
<td>PF DM refused</td>
<td>.78a</td>
<td>.81b</td>
<td>.3c</td>
<td>01</td>
</tr>
<tr>
<td>DMI (g.kg⁻¹.W⁰.⁷⁵.d⁻¹)</td>
<td>.69b</td>
<td>.63b</td>
<td>.62a</td>
<td>01</td>
</tr>
<tr>
<td>DMI (g.kg⁻¹.W⁰.⁷⁵.d⁻¹)</td>
<td>.87b</td>
<td>.76b</td>
<td>.27a</td>
<td>01</td>
</tr>
<tr>
<td>CPI (g.kg⁻¹.W⁰.⁷⁵.d⁻¹)</td>
<td>.527b</td>
<td>.555b</td>
<td>.431a</td>
<td>01</td>
</tr>
<tr>
<td>ADFI (g.kg⁻¹.W⁰.⁷⁵.d⁻¹)</td>
<td>.90b</td>
<td>.60b</td>
<td>.49a</td>
<td>01</td>
</tr>
</tbody>
</table>

a, b and c Means with different superscripts in the same row differs significantly.

Table 6. Digestible nutrient intake of goats (g.kg⁻¹.W⁰.⁷⁵) fed fresh, ensiled and pelleted oil palm frond

<table>
<thead>
<tr>
<th>samples</th>
<th>int fresh OPF</th>
<th>Diet ensiled OPF</th>
<th>Diet pelleted OPF</th>
<th>g. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI (g.kg⁻¹.W⁰.⁷⁵.d⁻¹)</td>
<td>.59a</td>
<td>.23b</td>
<td>.13a</td>
<td>01</td>
</tr>
<tr>
<td>OMI (g.kg⁻¹.W⁰.⁷⁵.d⁻¹)</td>
<td>.43b</td>
<td>.96b</td>
<td>.60a</td>
<td>01</td>
</tr>
<tr>
<td>CPI (g.kg⁻¹.W⁰.⁷⁵.d⁻¹)</td>
<td>756c</td>
<td>988b</td>
<td>217a</td>
<td>01</td>
</tr>
<tr>
<td>ADFI (g.kg⁻¹.W⁰.⁷⁵.d⁻¹)</td>
<td>637b</td>
<td>251b</td>
<td>1.247a</td>
<td>01</td>
</tr>
</tbody>
</table>

a, b and c Means with different superscripts in the same row differs significantly. DDMI, Digestible dry matter intake; DOMI, Digestible organic matter intake; DCPI, Digestible crude protein intake; DADFI, Digestible acid detergent fiber intake.